Figure 1 -- Flow Chart

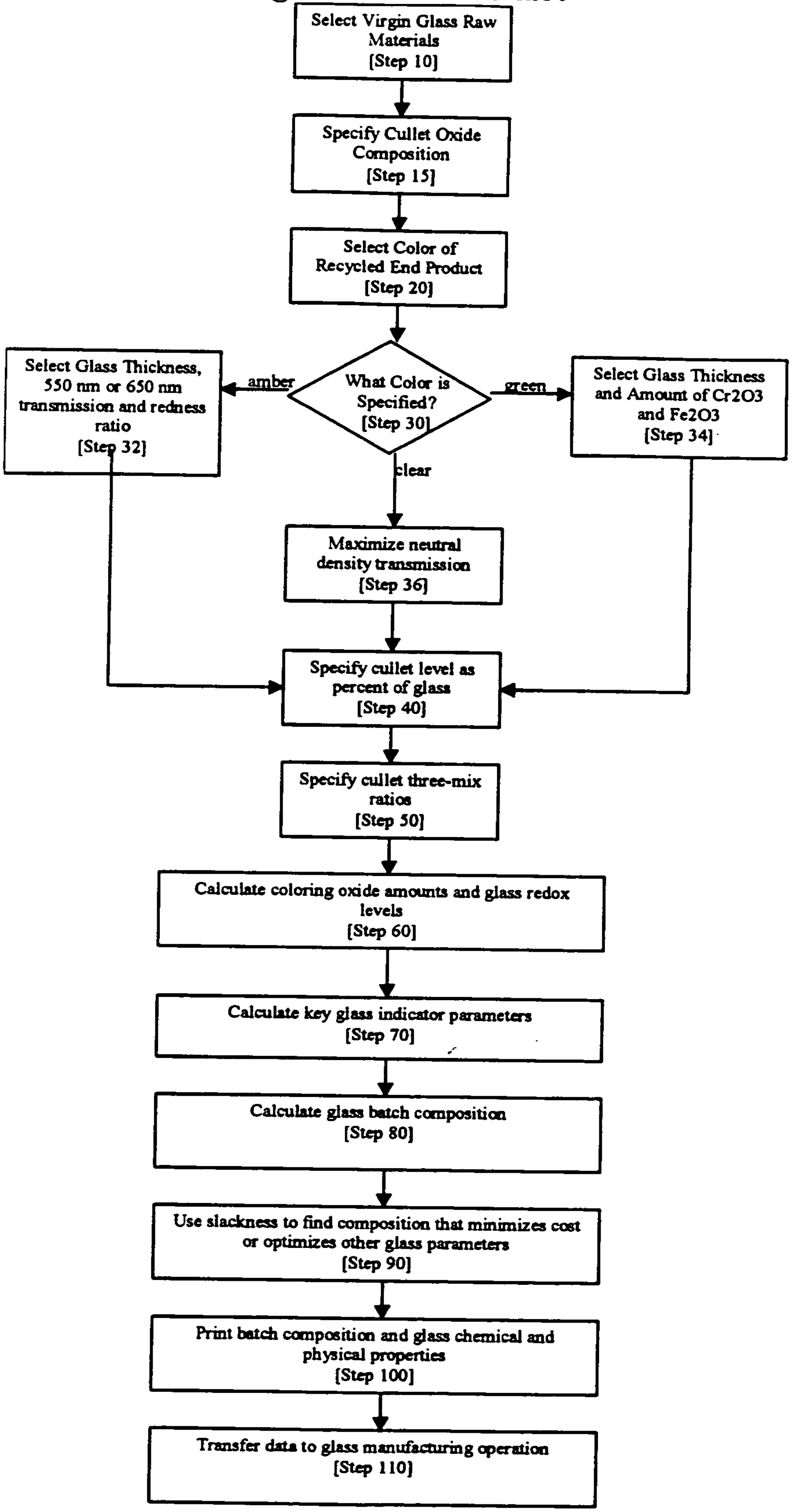
Select Virgin Glass Raw Materials [Step 10]
Specify Cullet Oxide Composition [Step 15]
Select Color of Recycled End Product [Step 20]
What Color is Specified? [Step 30]
amber
green
clear
Select Glass Thickness, 550 nm or 650 nm transmission and redness ratio [Step 32]
Select Glass Thickness and Amount of Cr2O3 and Fe2O3 [Step 34]
Maximize neutral density transmission [Step 36]
Specify cullet level as percent of glass [Step 40]
Specify cullet three-mix ratios [Step 50]
Calculate coloring oxide amounts and glass redox levels [Step 60]
Calculate key glass indicator parameters [Step 70]
Calculate glass batch composition [Step 80]
Use slackness to find composition that minimizes cost or optimizes other glass parameters [Step 90]
Print batch composition and glass chemical and physical properties [Step 100]
Transfer data to glass manufacturing operation [Step 110]

Figure 2(a)

Glass Batch Formulation with Mixed Cullet -- AMBER GLASS

Page 1 -- Main Program: Raw Materials and Input Values

Raw Materials Data Base: Standard Soda Lime Silicate

Scenario Name: 35% East/West Coast Blend

***** GLASS RAW MATERIALS (Enter raw material properties and costs) *****

Cullet		SiO2	Al2O3	CuO	CaO	MgO	BaO	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	COD	LOI	Total	RN
Clear		71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.15%	0.05%	0.20%	0.00%	0.05%	0 15%	99 99%	-1 19%
Amber		71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.29%	0.15%	0.25%	0.00%	0.10%	0.00%	100 18%	-2 37%
Green		71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.20%	0.10%	0.20%	0.20%	0.05%	0.00%	100 14%	-1 19%
Raw Materials	**Cost**																
Sand, US Silica	50 00	99.690%	0.094%		0.009%	0.006%		0.003%	0.016%	0.037%	0.023%			0.015%	0.122%	100 0%	0.00
Limestone	35.00	1.000%			54.910%	0.450%				0.050%				0.050%	43 590%	100 1%	-0 01
Aplite, US Silica	60.00	62.190%	22.320%		5.850%	0.036%		5.910%	2.750%	0.112%	0.530%	0.060%		0.012%	0.242%	100.0%	0 00
Calumite	48.00	36.480%	11.110%		36.930%	11.630%		0.500%	0.350%	0.280%	1.240%	1.250%		1.000%	0.230%	101.0%	-0 24
Salt Cake	155.00							43.600%				22.588%			33.812%	100.0%	1.00
Melite	52.00	28.345%	8.632%		28.695%	9.037%		0.389%	0.272%	22.300%	0.963%			1.000%	1.368%	101 0%	-0 24
Soda Ash	130.00							58.400%							41.600%	100 0%	0 00
Carbocite #20	35 00	8.800%	6.099%		0.192%	0.096%		0.704%		0.330%	0.291%	0.038%		78.000%	5.450%	100.0%	-18.49
Copper xide	1000.00			100.0%													

***** USER INPUT: SPECIFY GLASS COLOR AND CULLET USAGE HERE *****

	Goal	Suggest	Compute
Color (amber, green, clear)	amber		
Thickness, mm	3.18		
450 Transmission	0.0	0 0	
550 Transmission	11.5	11.5	11.2
Redness Ratio	2.0	2.3	2.0
650 Transmission	23.0	26.7	22.5
COD	calc		-52
Cullet, percent of glass:	35.0%		
Three Mix Ratio:			
Clear ====>	48.3		
Amber ====>	26.7		
Green ====>	25.0		

Note: Input in provided in the box to the left. User defined values are entered in the column "Goal". Suggested values are given in the center column, and computed values appear in the "Compute" Column. Shaded boxes in the Goal column do not accept input.

Note: Cullet percentages and three-mix ratios are entered in the respective boxes shown on the left. Cullet is expressed as a percent of the melted glass, and three-mix ratios are simply the relative amounts of each color cullet.

continued

Figure 2(b)

Glass Batch Formulation with Mixed Cullet -- AMBER GLASS

Page 2 -- Main Program: Calculated Values

***** GLASS BATCH FORMULA (computed batch weights appear in Batch Column) *****

Cullet		Wt. Lbs	Percent	SiO_2	Al_2O_3	CuO	CaO	MgO	BaO	Na_2O	K_2O	Fe_2O_3	TiO_2	S(total)	Cr_2O_3	COD	LOI	Total	RN
TOTAL		700																	
Clear		338	16.91%	243.09	5.75	0.00	37.53	2.47	0.00	46.66	0.54	0.51	0.17	0.68	0.00	0.17	0.51	338.07	-4.01
Amber		187	9.35%	134.38	3.18	0.00	20.75	1.36	0.00	25.79	0.30	0.55	0.28	0.47	0.00	0.19	0.00	187.24	-4.43
Green		175	8.75%	125.83	2.98	0.00	19.43	1.28	0.00	24.15	0.28	0.35	0.18	0.35	0.35	0.09	0.00	175.25	-2.07
		Batch																	
Raw Materials		Weight	Cost	SiO_2	Al_2O_3	CuO	CaO	MgO	BaO	Na_2O	K_2O	Fe_2O_3	TiO_2	S(total)	Cr_2O_3	COD	LOI	Total	RN
Sand, US Silica		855.2	21.38	852.55	0.80	0.00	0.08	0.05	0.00	0.03	0.14	0.31	0.20	0.00	0.00	0.13	1.04	855.33	-3.04
Limestone		146.1	2.56	1.46	0.00	0.00	80.22	0.66	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07	63.68	146.17	-1.73
Aplite, US Silica		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calumite		179.9	4.32	65.63	19.99	0.00	66.44	20.92	0.00	0.90	0.63	0.50	2.23	2.25	0.00	1.80	0.41	181.70	-42.64
Salt Cake		18.2	1.41	0.00	0.00	0.00	0.00	0.00	0.00	7.94	0.00	0.00	0.00	4.11	0.00	0.00	6.15	18.20	18.20
Melite - 40		7.63	0.20	2.16	0.66	0.00	2.19	0.69	0.00	0.03	0.02	1.70	0.07	0.00	0.00	0.08	0.10	7.71	-1.81
Soda Ash, FMC		282.5	18.36	0.00	0.00	0.00	0.00	0.00	0.00	164.98	0.00	0.00	0.00	0.00	0.00	0.00	117.52	282.50	0.00
Carbocite #20		0.54	0.01	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.03	0.54	-9.98
Copper Oxide		2.543E-01	0.13			0.25													
TOTALS		1490	48.36	1425.15	33.38	0.25	226.63	27.43	0.00	270.48	1.91	4.00	3.12	7.85	0.35	2.94	189.46	2192.95	-51.51

***** GLASS OXIDE FORMULA (Enter target glass composition) *****

		Total		Percent	Glass=100
Glass		2001		91.2%	100.00
LOI		192.40		8.8%	9.62
Total		2192.95		100.0%	109.62

Glass Oxides====>	SiO_2	Al_2O_3	CuO	CaO	MgO	BaO	Na_2O	K_2O	Fe_2O_3	TiO_2	S(total)	Cr_2O_3	COD	RN
Target Glass (default given) ==>	71.90%	1.70%		11.10%			13.80%	0.16%	0.200%		0.40%			
Calculated Oxide Composition ==>	71.24%	1.67%	0.01%	11.33%	1.37%	0.00%	13.52%	0.10%	0.20%	0.16%	0.39%	0.017%	0.15%	-51.51

***** *End of Main* *****

Figure 2(c)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: 35% East/West Coast Blend

Cullet Percentage **35.0%**

Cullet Color Percents
48.3 Clear
26.7 Amber
25.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	338		169.05	
Amber	187		93.45	
Green	175		87.5	
TOTAL		700	350	31.92%
Virgin Raw Materials				
Sand, US Silica		855.2	427.6	39.00%
Limestone		146.1	73.1	6.66%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		179.9	90.0	8.20%
Salt Cake		18.2	9.1	0.83%
Melite - 40		7.6	3.8	0.35%
Soda Ash, FMC		282.5	141.3	12.88%
Coal, Carbocite #20		0.54	0.27	0.02%
Copper Oxide		2.54E-01	1.27E-01	0.012%
TOTALS		2190.3	1095.2	99.88%
After Melting:				
Glass		2000.6	1000.3	
LOI		192.4	96.2	
Total		2193.0	1096.5	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.2%
Al2O3	1.7%
CaO	11.3%
MgO	1.4%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.156%
S(total)	0.393%
Cr2O3	0.017%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)	Amber
Thickness, mm	3.2
450 Transmission	0.0
550 Transmission	11.5
650 Transmission	23.0
Redness Ratio (T650/T550)	2.0
Batch Redox Number	-51.51

Figure 3

Visible Transmission Data for Selected Amber, Green and Clear Glasses

ID, # ==>	1	2	3	4	5	6	7	8	9	10
Type	Amber	Amber	Amber	Amber	Amber	Amber	Green	Clear	Green	Green
Brand	Stout	S. Adams	Paulaner	Budweiser	Miller	Coors	Becks		Heineken	Gallo
Wavelength										
400	0.00	0.00	0.06	0.00	0.00	0.00	58.08	69.71	57.76	59.65
450	0.01	0.00	0.29	0.00	0.01	0.01	19.34	70.04	22.36	21.71
500	1.01	0.89	4.66	0.79	1.07	0.86	43.21	71.28	45.38	40.94
550	9.81	10.32	20.35	9.84	11.92	9.94	67.45	70.97	67.21	56.00
600	17.92	21.02	28.83	21.44	22.79	21.49	36.89	71.85	40.10	41.19
650	18.88	22.69	27.96	25.02	24.64	24.39	21.01	72.08	25.16	29.15
700	20.87	23.40	26.57	27.79	27.44	25.14	26.84	71.90	31.88	38.15
☐										
Red Ratio	1.92	2.20	1.37	2.54	2.07	2.45	0.31	1.02	0.37	0.52

Figure 4

Cullet Composition Model

Data and Calculated Mixes

				Clear	Amber	Green
Approximate USA Production (from industry sources)➔				58.0%	32.0%	10.0%
	G	A				
USA production, plus imported glass of G% green A% amber	10.0%	0.0%		52.7%	29.1%	18.2%
	15.0%	0.0%		50.4%	27.8%	21.7%
	20.0%	0.0%		48.3%	26.7%	25.0%
	25.0%	0.0%		46.4%	25.6%	28.0%
	10.0%	5.0%		50.4%	32.2%	17.4%
	15.0%	5.0%		48.3%	30.8%	20.8%
	20.0%	5.0%		46.4%	29.6%	24.0%
	25.0%	5.0%		44.6%	28.5%	26.9%
	10.0%	10.0%		48.3%	35.0%	16.7%
	15.0%	10.0%		46.4%	33.6%	20.0%
	20.0%	10.0%		44.6%	32.3%	23.1%
	25.0%	10.0%		43.0%	31.1%	25.9%

Scenarios for Batch Calculations

				Clear	Amber	Green
USA Production				58.0%	32.0%	10.0%
East/West Coast Mix, (USA plus 20% green import)				48.3%	26.7%	25.0%
One third clear removed from USA Production				47.9%	39.7%	12.4%
Two-thirds clear removed from USA Production				31.5%	52.2%	16.3%
Trend to Amber: (USA GPI with 30% more amber)				52.9%	38.0%	9.1%
Beer Belt Blend (heavy amber, few imports)				55.0%	40.0%	5.0%
			Min	31.5%	26.7%	5.0%
			Max	58.0%	52.2%	25.0%

Figure 5
Extinction Coefficient Summary

ID, #	1	2	3	4	5	6	7	8	9	10
Type	Amber	Amber	Amber	Amber	Amber	Amber	Green	Clear	Green	Green
Brand	Stout	S. Adams	Paulaner	Budweiser	Miller	Coors	Becks		Heineken	Gallo
Wavelength										
400	3.536	3.305	2.286	3.817	4.442	4.176	0.143	0.086	0.145	0.135
450	2.962	3.344	1.815	3.111	2.905	3.047	0.489	0.084	0.443	0.453
500	1.418	1.459	0.937	1.495	1.399	1.467	0.236	0.079	0.221	0.253
550	0.703	0.687	0.473	0.702	0.641	0.698	0.096	0.080	0.097	0.155
600	0.513	0.463	0.364	0.457	0.438	0.456	0.286	0.076	0.260	0.251
650	0.497	0.439	0.373	0.408	0.413	0.416	0.463	0.075	0.406	0.360
700	0.465	0.429	0.389	0.375	0.379	0.407	0.386	0.076	0.332	0.276
☐										

Average Extinction Coefficients for Major Amber and Green manufacturers

	BMC Avg	BH Avg	Clear
450	3.021	0.466	0.084
550	0.680	0.097	0.080
600	0.450	0.393	0.273
650	0.412	0.435	0.075

Average 3.18 transmission for major amber and green manufacturers

	BMC Avg	BH Avg	Clear
550	10.525	67.333	70.971
600	21.897	26.238	38.475
650	24.683	22.992	72.080

Figure 6(a)

Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Amber w/35% Three-Mix, East/West Coast Blend

Cullet Percentage **50.0%**

Cullet Color Percents
48.3 Clear
26.7 Amber
25.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	483		241.5	
Amber	267		133.5	
Green	250		125	
TOTAL		1000	500	46.76%
Virgin Raw Materials				
Sand, US Silica		660.1	330.0	30.86%
Limestone		90.9	45.5	4.25%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		148.7	74.4	6.96%
Salt Cake		17.0	8.5	0.80%
Melite - 40		5.7	2.9	0.27%
Soda Ash, FMC		212.8	106.4	9.95%
Coal, Carbocite #20		0.61	0.3055	0.03%
Copper Oxide		3.295E-01	0.1647	0.015%
TOTALS		2136.2	1068.1	99.88%
After Melting:				
Glass		2000.0	1000.0	
LOI		138.7	69.3	
Total		2138.7	1069.3	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.7%
Al2O3	1.7%
CaO	10.9%
MgO	1.3%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.147%
S(total)	0.392%
Cr2O3	0.025%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-49.32

Figure 6(b)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: East/West Coast Blend

Cullet Percentage **75.0%**

Cullet Color Percents
48.3 Clear
26.7 Amber
25.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	725		362.25	
Amber	401		200.25	
Green	375		187.5	
TOTAL		1500	750	72.57%
Virgin Raw Materials				
Sand, US Silica		331.7	165.9	16.05%
Limestone		39.6	19.8	1.92%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		77.1	38.5	3.73%
Salt Cake		16.3	8.1	0.79%
Melite - 40		2.8	1.4	0.13%
Soda Ash, FMC		95.8	47.9	4.64%
Coal, Carbocite #20		1.02	0.5113	0.05%
Copper Oxide		6.226E-01	0.3113	0.030%
TOTALS		2065.0	1032.5	99.90%
After Melting:				
Glass		2000.0	1000.0	
LOI		67.0	33.5	
Total		2067.0	1033.5	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.9%
Al2O3	1.7%
CaO	10.9%
MgO	1.0%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.120%
S(total)	0.392%
Cr2O3	0.038%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-45.73

Figure 7(a)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production Three Mix

Cullet Percentage **25.0%**

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	290		145	
Amber	160		80	
Green	50		25	
TOTAL		500	250	22.62%
Virgin Raw Materials				
Sand,-US Silica		988.6	494.3	44.72%
Limestone		142.2	71.1	6.43%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		220.4	110.2	9.97%
Salt Cake		17.7	8.9	0.80%
Melite - 40		8.7	4.4	0.39%
Soda Ash, FMC		329.8	164.9	14.92%
Coal, Carbocite #20		0.22	0.1082	0.01%
Copper Oxide		0.000	0.000	0.000
TOTALS		2207.6	1103.8	99.87%
After Melting:				
Glass		2000.0	1000.0	
LOI		210.4	105.2	
Total		2210.4	1105.2	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.5%
Al2O3	1.7%
CaO	10.9%
MgO	1.5%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.174%
S(total)	0.392%
Cr2O3	0.005%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.59

Figure 7(b)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production Three Mix

Cullet Percentage **50.0%**

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	580		290	
Amber	320		160	
Green	100		50	
TOTAL		1000	500	46.75%
Virgin Raw Materials				
Sand, US Silica		660.7	330.4	30.89%
Limestone		91.0	45.5	4.25%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		148.7	74.3	6.95%
Salt Cake		16.9	8.5	0.79%
Melite - 40		5.7	2.9	0.27%
Soda Ash, FMC		212.9	106.4	9.95%
Coal, Carbocite #20		0.79	0.3960	0.04%
Copper Oxide		0.000	0.000	0.000
TOTALS		2136.7	1068.3	99.89%
After Melting:				
Glass		2000.0	1000.0	
LOI		139.0	69.5	
Total		2139.0	1069.5	

Oxide Composition

Oxide	Wt. Pct.
SiO_2	71.7%
Al_2O_3	1.7%
CaO	10.9%
MgO	1.3%
Na_2O	13.5%
K_2O	0.1%
Fe_2O_3	0.200%
TiO_2	0.146%
S(total)	0.392%
Cr_2O_3	0.010%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.38

Figure 7(c)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production Three Mix

Cullet Percentage 75.0%

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	870		435	
Amber	480		240	
Green	150		75	
TOTAL		1500	750	72.55%
Virgin Raw Materials				
Sand, US Silica		332.8	166.4	16.10%
Limestone		39.7	19.9	1.92%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		76.9	38.5	3.72%
Salt Cake		16.1	8.1	0.78%
Melite - 40		2.8	1.4	0.13%
Soda Ash, FMC		96.0	48.0	4.64%
Coal, Carbocite #20		1.31	0.6567	0.06%
Copper Oxide		0.095	0.047	0.000
TOTALS		2065.7	1032.8	99.91%
After Melting:				
Glass		2000.0	1000.0	
LOI		67.6	33.8	
Total		2067.6	1033.8	

Oxide Composition

Oxide	Wt. Pct.
SiO_2	72.0%
Al_2O_3	1.7%
CaO	10.9%
MgO	1.0%
Na_2O	13.5%
K_2O	0.1%
Fe_2O_3	0.200%
TiO_2	0.118%
S(total)	0.392%
Cr_2O_3	0.015%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)	Amber
Thickness, mm	3.2
450 Transmission	0.0
550 Transmission	11.5
650 Transmission	23.0
Redness Ratio (T650/T550)	2.0
Batch Redox Number	-52.18

Figure 8(a)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production, 1/3 clear removed

Cullet Percentage **25.0%**

Cullet Color Percents
47.9 Clear
39.7 Amber
12.4 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	240		119.75	
Amber	199		99.25	
Green	62		31	
TOTAL		500	250	22.62%
Virgin Raw Materials				
Sand, US Silica		988.5	494.3	44.72%
Limestone		142.2	71.1	6.43%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		220.6	110.3	9.98%
Salt Cake		17.6	8.8	0.80%
Melite - 40		8.4	4.2	0.38%
Soda Ash, FMC		329.8	164.9	14.92%
Coal, Carbocite #20		0.18	0.0921	0.01%
Copper Oxide		0.000	0.000	0.000
TOTALS		2207.4	1103.7	99.87%
After Melting:				
Glass		2000.0	1000.0	
LOI		210.3	105.2	
Total		2210.3	1105.2	

Oxide Composition

Oxide	Wt. Pct.
SiO_2	71.5%
Al_2O_3	1.7%
CaO	10.9%
MgO	1.5%
Na_2O	13.5%
K_2O	0.1%
Fe_2O_3	0.200%
TiO_2	0.176%
S(total)	0.392%
Cr_2O_3	0.006%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.54

Figure 8(b)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production, 1/3 clear removed

Cullet Percentage **50.0%**

Cullet Color Percents
47.9 Clear
39.7 Amber
12.4 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	479		239.5	
Amber	397		198.5	
Green	124		62	
TOTAL		1000	500	46.75%
Virgin Raw Materials				
Sand, US Silica		660.6	330.3	30.88%
Limestone		90.9	45.5	4.25%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		149.1	74.6	6.97%
Salt Cake		16.7	8.4	0.78%
Melite - 40		5.2	2.6	0.24%
Soda Ash, FMC		213.0	106.5	9.96%
Coal, Carbocite #20		0.71	0.3543	0.03%
Copper Oxide		0.034	0.017	0.000
TOTALS		2136.3	1068.1	99.88%
After Melting:				
Glass		2000.0	1000.0	
LOI		138.8	69.4	
Total		2138.8	1069.4	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.7%
Al2O3	1.7%
CaO	10.9%
MgO	1.3%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.150%
S(total)	0.392%
Cr2O3	0.012%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)	Amber
Thickness, mm	3.2
450 Transmission	0.0
550 Transmission	11.5
650 Transmission	23.0
Redness Ratio (T650/T550)	2.0
Batch Redox Number	-52.93

Figure 8(c)
Glass Batch Formulations Using 3-Mix Cullet Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production, 1/3 clear removed

Cullet Percentage **75.0%**

Cullet Color Percents
47.9 Clear
39.7 Amber
12.4 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	719		359.25	
Amber	596		297.75	
Green	186		93	
TOTAL		1500	750	72.56%
Virgin Raw Materials				
Sand, US Silica		332.5	166.2	16.08%
Limestone		39.7	19.8	1.92%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		77.7	38.8	3.76%
Salt Cake		15.8	7.9	0.76%
Melite - 40		1.9	1.0	0.09%
Soda Ash, FMC		96.2	48.1	4.65%
Coal, Carbocite #20		1.17	0.5845	0.06%
Copper Oxide		0.179	0.090	0.000
TOTALS		2065.1	1032.5	99.90%
After Melting:				
Glass		2000.0	1000.0	
LOI		67.2	33.6	
Total		2067.2	1033.6	

Oxide Composition

Oxide	Wt. Pct.
SiO_2	72.0%
Al_2O_3	1.7%
CaO	10.9%
MgO	1.0%
Na_2O	13.5%
K_2O	0.1%
Fe_2O_3	0.200%
TiO_2	0.124%
S(total)	0.392%
Cr_2O_3	0.019%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-51.15

Figure 9(a)

Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production, 2/3 clear removed

Cullet Percentage **25.0%**

Cullet Color Percents
31.5 Clear
52.2 Amber
16.3 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	158		78.75	
Amber	261		130.5	
Green	82		40.75	
TOTAL		500	250	22.62%
Virgin Raw Materials				
Sand, US Silica		988.4	494.2	44.72%
Limestone		142.2	71.1	6.43%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		221.0	110.5	10.00%
Salt Cake		17.5	8.7	0.79%
Melite - 40		8.0	4.0	0.36%
Soda Ash, FMC		330.0	165.0	14.93%
Coal, Carbocite #20		0.13	0.0661	0.01%
Copper Oxide		0.000	0.000	0.000
TOTALS		2207.1	1103.6	99.86%
After Melting:				
Glass		2000.0	1000.0	
LOI		210.2	105.1	
Total		2210.2	1105.1	

Oxide Composition

Oxide	Wt. Pct.
SiO_2	71.5%
Al_2O_3	1.7%
CaO	10.9%
MgO	1.5%
Na_2O	13.5%
K_2O	0.1%
Fe_2O_3	0.200%
TiO_2	0.180%
S(total)	0.392%
Cr_2O_3	0.008%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.46

Figure 9(b)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production, 2/3 clear removed

Cullet Percentage **50.0%**

Cullet Color Percents
31.5 Clear
52.2 Amber
16.3 Green

Batch Formulation

Oxide Composition

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	315		157.5	
Amber	522		261	
Green	163		81.5	
TOTAL		1000	500	46.68%
Virgin Raw Materials				
Sand, US Silica		667.5	333.8	31.16%
Limestone		99.1	49.5	4.63%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		137.6	68.8	6.42%
Salt Cake		17.1	8.5	0.80%
Melite - 40		4.4	2.2	0.21%
Soda Ash, FMC		212.8	106.4	9.94%
Coal, Carbocite #20		0.74	0.3693	0.03%
Copper Oxide		0.125	0.063	0.000
TOTALS		2139.4	1069.7	99.87%
After Melting:				
Glass		2000.0	1000.0	
LOI		142.1	71.1	
Total		2142.1	1071.1	

Oxide	Wt. Pct.
SiO_2	71.8%
Al_2O_3	1.7%
CaO	10.9%
MgO	1.2%
Na_2O	13.5%
K_2O	0.1%
Fe_2O_3	0.200%
TiO_2	0.150%
S(total)	0.392%
Cr_2O_3	0.016%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-51.81

Figure 9(c)

Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production, 2/3 clear removed

Cullet Percentage 75.0%

Cullet Color Percents
31.5 Clear
52.2 Amber
16.3 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	473		236.25	
Amber	783		391.5	
Green	245		122.25	
TOTAL		1500	750	72.58%
Virgin Raw Materials				
Sand, US Silica		332.0	166.0	16.06%
Limestone		39.6	19.8	1.92%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		78.9	39.4	3.82%
Salt Cake		15.3	7.7	0.74%
Melite - 40		0.6	0.3	0.03%
Soda Ash, FMC		96.5	48.3	4.67%
Coal, Carbocite #20		0.93	0.4672	0.05%
Copper Oxide		0.317	0.158	0.000
TOTALS		2064.1	1032.1	99.87%
After Melting:				
Glass		2000.0	1000.0	
LOI		66.7	33.3	
Total		2066.7	1033.3	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.9%
Al2O3	1.7%
CaO	10.9%
MgO	1.0%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.135%
S(total)	0.392%
Cr2O3	0.024%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-49.47

Figure 10(a)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Trend to Amber

Cullet Percentage **25.0%**

Cullet Color Percents
52.9 Clear
38.0 Amber
9.1 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	265		132.25	
Amber	190		95	
Green	46		22.75	
TOTAL		500	250	22.62%
Virgin Raw Materials				
Sand, US Silica		988.6	494.3	44.72%
Limestone		142.2	71.1	6.43%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		220.6	110.3	9.98%
Salt Cake		17.7	8.8	0.80%
Melite - 40		8.5	4.3	0.39%
Soda Ash, FMC		329.8	164.9	14.92%
Coal, Carbocite #20		0.19	0.0972	0.01%
Copper Oxide		0.000	0.000	0.000
TOTALS		2207.5	1103.8	99.87%
After Melting:				
Glass		2000.0	1000.0	
LOI		210.4	105.2	
Total		2210.4	1105.2	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.5%
Al2O3	1.7%
CaO	10.9%
MgO	1.5%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.175%
S(total)	0.392%
Cr2O3	0.005%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.60

Figure 10(b)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Trend to Amber

Cullet Percentage **50.0%**

Cullet Color Percents
52.9 Clear
38.0 Amber
9.1 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	529		264.5	
Amber	380		190	
Green	91		45.5	
TOTAL		1000	500	46.75%
Virgin Raw Materials				
Sand, US Silica		660.7	330.3	30.89%
Limestone		91.0	45.5	4.25%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		149.0	74.5	6.96%
Salt Cake		16.8	8.4	0.78%
Melite - 40		5.4	2.7	0.25%
Soda Ash, FMC		213.0	106.5	9.96%
Coal, Carbocite #20		0.75	0.3741	0.03%
Copper Oxide		0.000	0.000	0.000
TOTALS		2136.5	1068.2	99.89%
After Melting:				
Glass		2000.0	1000.0	
LOI		138.9	69.5	
Total		2138.9	1069.5	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.7%
Al2O3	1.7%
CaO	10.9%
MgO	1.3%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.148%
S(total)	0.392%
Cr2O3	0.009%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.42

Figure 10(c)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Trend to Amber

Cullet Percentage **75.0%**

Cullet Color Percents
52.9 Clear
38.0 Amber
9.1 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	794		396.75	
Amber	570		285	
Green	137		68.25	
TOTAL		1500	750	72.55%
Virgin Raw Materials				
Sand, US Silica		332.7	166.4	16.09%
Limestone		39.7	19.9	1.92%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		77.4	38.7	3.74%
Salt Cake		15.9	7.9	0.77%
Melite - 40		2.2	1.1	0.11%
Soda Ash, FMC		96.1	48.1	4.65%
Coal, Carbocite #20		1.27	0.6329	0.06%
Copper Oxide		0.063	0.032	0.000
TOTALS		2065.4	1032.7	99.90%
After Melting:				
Glass		2000.0	1000.0	
LOI		67.4	33.7	
Total		2067.4	1033.7	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.0%
Al2O3	1.7%
CaO	10.9%
MgO	1.0%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.122%
S(total)	0.392%
Cr2O3	0.014%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-52.57

Figure 11(a)
Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Beer Belt Blend

Cullet Percentage **25.0%**

Cullet Color Percents

55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

Oxide Composition

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	275		137.5	
Amber	200		100	
Green	25		12.5	
TOTAL		500	250	22.62%
Virgin Raw Materials				
Sand, US Silica		988.6	494.3	44.73%
Limestone		142.2	71.1	6.43%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		220.6	110.3	9.98%
Salt Cake		17.6	8.8	0.80%
Melite - 40		8.5	4.3	0.38%
Soda Ash, FMC		329.8	164.9	14.92%
Coal, Carbocite #20		0.21	0.1071	0.01%
Copper Oxide		0.000	0.000	0.000
TOTALS		2207.6	1103.8	99.87%
After Melting:				
Glass		2000.0	1000.0	
LOI		210.4	105.2	
Total		2210.4	1105.2	

Oxide	Wt. Pct.
SiO2	71.5%
Al2O3	1.7%
CaO	10.9%
MgO	1.5%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.175%
S(total)	0.392%
Cr2O3	0.002%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-54.11

Figure 11(b)

Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Beer Belt Blend

Cullet Percentage **50.0%**

Cullet Color Percents
55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	550		275	
Amber	400		200	
Green	50		25	
TOTAL		1000	500	46.75%
Virgin Raw Materials				
Sand, US Silica		660.8	330.4	30.89%
Limestone		91.0	45.5	4.25%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		149.0	74.5	6.97%
Salt Cake		16.7	8.4	0.78%
Melite - 40		5.3	2.7	0.25%
Soda Ash, FMC		213.0	106.5	9.96%
Coal, Carbocite #20		0.74	0.3710	0.03%
Copper Oxide		0.000	0.000	0.000
TOTALS		2136.5	1068.3	99.89%
After Melting:				
Glass		2000.0	1000.0	
LOI		139.0	69.5	
Total		2139.0	1069.5	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.7%
Al2O3	1.7%
CaO	10.9%
MgO	1.3%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.148%
S(total)	0.392%
Cr2O3	0.005%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.59

Figure 11(c)
Glass Batch Formulations Using 3-Mix Cullet Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Beer Belt Blend

Cullet Percentage **75.0%**

Cullet Color Percents
55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	825		412.5	
Amber	600		300	
Green	75		37.5	
TOTAL		1500	750	72.55%
Virgin Raw Materials				
Sand, US Silica		332.9	166.5	16.10%
Limestone		39.7	19.9	1.92%
Aplite, US Silica		0.0	0.0	0.00%
Calumite		77.4	38.7	3.75%
Salt Cake		15.8	7.9	0.76%
Melite - 40		2.2	1.1	0.10%
Soda Ash, FMC		96.2	48.1	4.65%
Coal, Carbocite #20		1.29	0.6463	0.06%
Copper Oxide		0.000	0.000	0.000
TOTALS		2065.5	1032.8	99.90%
After Melting:				
Glass		2000.0	1000.0	
LOI		67.5	33.8	
Total		2067.5	1033.8	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.0%
Al2O3	1.7%
CaO	10.9%
MgO	1.0%
Na2O	13.5%
K2O	0.1%
Fe2O3	0.200%
TiO2	0.122%
S(total)	0.392%
Cr2O3	0.008%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Amber
Thickness, mm		3.2
450 Transmission		0.0
550 Transmission		11.5
650 Transmission		23.0
Redness Ratio (T650/T550)		2.0
Batch Redox Number		-53.48

Figure 12(a)

Glass Batch Formulation with Mixed Cullet -- GREEN GLASS

Page 1 -- Main Program: Raw Materials and Input Values

Raw Materials Data Base: Standard Soda Lime Silicate

Scenario Name: East/West Coast Three Mix

***** GLASS RAW MATERIALS (Enter raw material properties and costs) *****

Cullet			SiO2	Al2O3	CuO	CaO	MgO	BaO	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	COD	LOI	Total	RN
Clear			71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.15%	0.05%	0.20%	0.00%	0.05%	0.15%	99.99%	-1.19%
Amber			71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.29%	0.15%	0.25%	0.00%	0.10%	0.00%	100.18%	-2.37%
Green			71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.20%	0.10%	0.20%	0.20%	0.05%	0.00%	100.14%	-1.19%
Raw Materials	Cost																	
Sand, US Silica	50.00		99.690%	0.094%		0.009%	0.006%		0.003%	0.016%	0.037%	0.023%			0.015%	0.122%	100.0%	0.00
Limestone	35.00		1.000%			54.910%	0.450%				0.050%				0.050%	43.590%	100.1%	-0.01
Aplite, US Silica	60.00		62.190%	22.320%		5.850%	0.036%		5.910%	2.750%	0.112%	0.530%	0.060%		0.012%	0.242%	100.0%	0.00
Calumite	48.00		36.480%	11.110%		36.930%	11.630%		0.500%	0.350%	0.280%	1.240%	1.250%		1.000%	0.230%	101.0%	-0.24
Salt Cake	155.00								43.600%				22.588%			33.812%	100.0%	1.00
Melite	52.00		28.345%	8.632%		28.695%	9.037%		0.389%	0.272%	22.300%	0.963%			1.000%	1.368%	101.0%	-0.24
Soda Ash	130.00								58.400%							41.600%	100.0%	0.00
Carbocite #20	35.00		8.800%	6.099%		0.192%	0.096%		0.704%		0.330%	0.291%	0.038%		78.000%	5.450%	100.0%	-18.49
Iron Chromite, FeCr2O4	948.00										31.500%			45.900%	0.500%	22.600%	100.5%	-0.12
Chrome Oxide, Cr2O3	1250.00										0.000%			100.000%	0.000%	0.000%	100.0%	0.00

***** USER INPUT: SPECIFY GLASS COLOR AND CULLET USAGE HERE *****

	User Input	Reference	Computed	
Color (amber, green, clear)	Green			<============ Color of Glass, Fixed as GREEN
Thickness, mm	3.18			<============ Thickness of transmission specimen, Fixed as 3.18 mm
Cr2O3 Conc in Glass	0.23%	0.230%	0.229%	<============ Enter target Cr2O3 Concentration
Fe2O3 Conc in Glass	0.25%	0.250%	0.250%	<============ Enter target Fe2O3 Concentration
550 Transmission		73.5	70.2	
Redox Number	-30	-30	-30	<============ Enter target Redox Number
Cullet, percent of glass:	35.0%			<============ Enter cullet fraction, as a percent of glass
Three Mix Ratio:				<============ Enter three-mix ratios
Clear ====>	47.2			
Amber ====>	27.2			
Green ====>	25.5			

continued

Figure 12(b)

Glass Batch Formulation with Mixed Cullet – GREEN GLASS

Page 2 -- Main Program: Calculated Values

***** GLASS BATCH FORMULA (computed batch weights appear in Batch Column) *****

Cullet	Wt. Lbs	Percent	SiO2	Al2O3	CuO	CaO	MgO	BaO	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	COD	LOI	Total	RN
TOTAL	700																	
Clear	331	16.54%	237.78	5.62	0.00	36.71	2.41	0.00	45.64	0.53	0.50	0.17	0.66	0.00	0.17	0.50	330.68	-3.92
Amber	191	9.53%	137.11	3.24	0.00	21.17	1.39	0.00	26.32	0.31	0.56	0.28	0.48	0.00	0.19	0.00	191.05	-4.52
Green	179	8.93%	128.40	3.04	0.00	19.82	1.30	0.00	24.65	0.29	0.36	0.18	0.36	0.36	0.09	0.00	178.84	-2.12

Raw Materials	Batch Weight	Cost	SiO2	Al2O3	CuO	CaO	MgO	BaO	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	COD	LOI	Total	RN
Sand, US Silica, #4	875.8	40.00	873.07	0.82	0.00	0.08	0.05	0.00	0.03	0.14	0.32	0.20	0.00	0.00	0.13	1.07	875.91	-3.11
Limestone, Global Stone	259.9	20.00	2.60	0.00	0.00	142.72	1.17	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.13	113.30	260.04	-3.08
Aplite, US Silica	97.53	40.00	60.65	21.77	0.00	5.71	0.04	0.00	5.76	2.68	0.11	0.52	0.06	0.00	0.01	0.24	97.54	-0.28
Calumite, Weirton, WV	0.0	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Salt Cake	24.1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	10.51	0.00	0.00	0.00	5.45	0.00	0.00	8.15	24.11	24.11
Melite - 40, Moundsville	0.80	50.00	0.23	0.07	0.00	0.23	0.07	0.00	0.00	0.00	0.18	0.01	0.00	0.00	0.01	0.01	0.81	-0.19
Soda Ash, FMC, TG, RP	269.8	50.00	0.00	0.00	0.00	0.00	0.00	0.00	157.56	0.00	0.00	0.00	0.00	0.00	0.00	112.23	269.79	0.00
Carbocite #20	1.94	18.00	0.17	0.12	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	1.51	0.11	1.94	-35.82
Iron Chromite, FeCr2O4	9.010E+00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	0.00	4.14	0.05	2.04	9.05	-1.07
Chrome Oxide, Cr2O3	9.400E-02	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.09	0.00
TOTALS	1539	388.00	1440.02	34.68	0.00	226.44	6.44	0.00	270.48	3.94	5.00	1.36	7.00	4.59	2.28	237.63	2239.87	-30.00

***** GLASS OXIDE FORMULA (Enter target glass composition) *****

	Total	Percent	Glass=100
Glass	1999.95	89.3%	100.00
LOI	239.92	10.7%	12.00
Total	2239.87	100.0%	112.00

Glass Oxides===>	SiO2	Al2O3	CaO	MgO	BaO	Na2O	K2O	Fe2O3	TiO2	S(tot)	Cr2O3	COD	RN
Target Glass (default given) ==>	71.90%	1.70%	11.10%			13.80%	0.16%	0.250%		0.350%	0.230%		-30
Calculated Oxide Composition ==>	72.00%	1.73%	11.32%	0.32%	0.00%	13.52%	0.20%	0.250%	0.068%	0.350%	0.229%	0.114%	-30

***** *End of Main* *****

Figure 12(c)

Green Glass Batch Formulations Using 3-Mix Cullet Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: East/West Coast Three Mix

Cullet Percentage 35.0%

Cullet Color Percents
47.2 Clear
27.2 Amber
25.5 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	331		165.4	
Amber	191		95.3	
Green	179		89.3	
TOTAL		700	350	31.25%
Virgin Raw Materials				
Sand, US Silica		875.8	437.9	39.10%
Limestone		259.9	130.0	11.60%
Aplite, US Silica		97.53	48.8	4.35%
Calumite		0.0	0.0	0.00%
Salt Cake		24.1	12.1	1.08%
Melite - 40		0.80	0.4	0.04%
Soda Ash, FMC		269.8	134.9	12.05%
Coal, Carbocite #20		1.94	1.0	0.09%
Iron Chromite, FeCr2O4		9.010E+00	4.5048	0.402%
Chrome Oxide, Cr2O3		9.400E-02	0.0470	0.004%
TOTALS		2239.0	1119.5	99.96%
After Melting:				
Glass		2000.0	1000.0	
LOI		239.9	120.0	
Total		2239.9	1119.9	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.0%
Al2O3	1.7%
CaO	11.3%
MgO	0.3%
Na2O	13.5%
K2O	0.2%
Fe2O3	0.250%
TiO2	0.068%
S(total)	0.350%
Cr2O3	0.229%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Green
Thickness, mm		3.18
550 Transmission		70.2
Redox Number		-30.00

Figure 12(d)

Green Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: East/West Coast Three Mix

Cullet Percentage 70.0%

Cullet Color Percents
47.2 Clear
27.2 Amber
25.5 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	2000 lbs glass	1000 g glass	Percent
Clear	661		330.7	
Amber	381		190.7	
Green	357		178.6	
TOTAL		1400	700	66.02%
Virgin Raw Materials				
Sand, US Silica		388.9	194.5	18.34%
Limestone		124.3	62.2	5.86%
Aplite, US Silica		46.77	23.4	2.21%
Calumite		0.0	0.0	0.00%
Salt Cake		17.6	8.8	0.83%
Melite - 40		0.00	0.0	0.00%
Soda Ash, FMC		133.3	66.7	6.29%
Coal, Carbocite #20		1.23	0.6	0.06%
Iron Chromite, FeCr2O4		6.055E+00	3.0277	0.286%
Chrome Oxide, Cr2O3		1.106E+00	0.5531	0.052%
TOTALS		2119.3	1059.7	99.94%
After Melting:				
Glass		2000.0	1000.0	
LOI		120.6	60.3	
Total		2120.6	1060.3	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.2%
Al2O3	1.7%
CaO	11.3%
MgO	0.5%
Na2O	14.1%
K2O	0.2%
Fe2O3	0.250%
TiO2	0.080%
S(total)	0.350%
Cr2O3	0.230%
Total	100.0%

Glass Color and Redox Properties

Figure 13(a)
Green Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production Three Mix

Cullet Percentage **25.0%**

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	290		145.0	
Amber	160		80.0	
Green	50		25.0	
TOTAL		500	250	21.90%
Virgin Raw Materials				
Sand, US Silica		1033.0	516.5	45.25%
Limestone		286.0	143.0	12.53%
Aplite, US Silica		106.89	53.4	4.68%
Calumite		0.0	0.0	0.00%
Salt Cake		26.1	13.0	1.14%
Melite - 40		1.42	0.7	0.06%
Soda Ash, FMC		317.2	158.6	13.89%
Coal, Carbocite #20		2.13	1.1	0.09%
Iron Chromite, FeCr2O4		9.699E+00	4.850E+00	4.248E-03
Chrome Oxide, Cr2O3		0.000E+00	0.000E+00	0.000E+00
TOTALS		2282.4	1141.2	99.97%
After Melting:				
Glass		2011.0	1005.5	
LOI		272.1	136.0	
Total		2283.1	1141.5	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.6%
Al2O3	1.7%
CaO	10.9%
MgO	0.3%
Na2O	13.5%
K2O	0.2%
Fe2O3	0.250%
TiO2	0.062%
S(total)	0.350%
Cr2O3	0.226%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Green
Thickness, mm		3.18
550 Transmission		70.6
Redox Number		-30.00

Figure 13(b)
Green Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production Three Mix

Cullet Percentage **50.0%**

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs. (by color)	Weight, lbs. (2000 lbs glass)	Weight, g (1000 g glass)	Percent
Cullet				
Clear	580		290.0	
Amber	320		160.0	
Green	100		50.0	
TOTAL		1000	500	45.59%
Virgin Raw Materials				
Sand, US Silica		660.8	330.4	30.13%
Limestone		201.6	100.8	9.19%
Aplite, US Silica		75.68	37.8	3.45%
Calumite		0.0	0.0	0.00%
Salt Cake		21.2	10.6	0.97%
Melite - 40		0.81	0.4	0.04%
Soda Ash, FMC		222.2	111.1	10.13%
Coal, Carbocite #20		1.60	0.8	0.07%
Iron Chromite, FeCr2O4		7.533E+00	3.767E+00	3.435E-03
Chrome Oxide, Cr2O3		9.332E-01	4.666E-01	4.255E-04
TOTALS		2192.4	1096.2	99.96%
After Melting:				
Glass		2000.0	1000.0	
LOI		193.3	96.7	
Total		2193.3	1096.7	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.4%
Al2O3	1.7%
CaO	11.3%
MgO	0.4%
Na2O	14.1%
K2O	0.2%
Fe2O3	0.250%
TiO2	0.071%
S(total)	0.350%
Cr2O3	0.230%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Green
Thickness, mm		3.18
550 Transmission		70.2
Redox Number		-30.00

Figure 13(c)

Green Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: USA Production Three Mix

Cullet Percentage **75.0%**

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	870		435.0	
Amber	480		240.0	
Green	150		75.0	
TOTAL		1500	750	71.34%
Virgin Raw Materials				
Sand, US Silica		320.9	160.4	15.26%
Limestone		104.6	52.3	4.98%
Aplite, US Silica		39.26	19.6	1.87%
Calumite		0.0	0.0	0.00%
Salt Cake		16.5	8.3	0.79%
Melite - 40		0.56	0.3	0.03%
Soda Ash, FMC		111.2	55.6	5.29%
Coal, Carbocite #20		1.07	0.5	0.05%
Iron Chromite, FeCr2O4		5.195E+00	2.598E+00	2.471E-03
Chrome Oxide, Cr2O3		1.953E+00	9.764E-01	9.289E-04
TOTALS		2101.3	1050.7	99.95%
After Melting:				
Glass		2000.0	1000.0	
LOI		102.5	51.2	
Total		2102.5	1051.2	

Oxide Composition

Oxide	Wt. Pct.
SiO2	71.2%
Al2O3	1.7%
CaO	11.3%
MgO	0.6%
Na2O	14.1%
K2O	0.2%
Fe2O3	0.250%
TiO2	0.079%
S(total)	0.350%
Cr2O3	0.232%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Green
Thickness, mm		3.18
550 Transmission		70.0
Redox Number		-30.00

Figure 14(a)

Green Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Beer Belt Blend

Cullet Percentage **25.0%**

Cullet Color Percents
55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	275		137.5	
Amber	200		100.0	
Green	25		12.5	
TOTAL		500	250	22.11%
Virgin Raw Materials				
Sand, US Silica		1021.4	510.7	45.17%
Limestone		281.8	140.9	12.46%
Aplite, US Silica		105.42	52.7	4.66%
Calumite		0.0	0.0	0.00%
Salt Cake		25.7	12.9	1.14%
Melite - 40		0.94	0.5	0.04%
Soda Ash, FMC		313.4	156.7	13.86%
Coal, Carbocite #20		2.10	1.0	0.09%
Iron Chromite, FeCr2O4		9.775E+00	4.888E+00	4.323E-03
Chrome Oxide, Cr2O3		0.000E+00	0.000E+00	0.000E+00
TOTALS		2260.5	1130.3	99.97%
After Melting:				
Glass		1992.8	996.4	
LOI		268.5	134.2	
Total		2261.2	1130.6	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.6%
Al2O3	1.7%
CaO	10.9%
MgO	0.3%
Na2O	13.5%
K2O	0.2%
Fe2O3	0.250%
TiO2	0.064%
S(total)	0.350%
Cr2O3	0.228%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Green
Thickness, mm		3.18
550 Transmission		70.4
Redox Number		-30.00

Figure 14(b)
Green Glass Batch Formulations Using 3-Mix Cullet Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Beer Belt Blend

Cullet Percentage **50.0%**

Cullet Color Percents
55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	550		275.0	
Amber	400		200.0	
Green	50		25.0	
TOTAL		1000	500	45.59%
Virgin Raw Materials				
Sand, US Silica		660.8	330.4	30.13%
Limestone		201.7	100.9	9.20%
Aplite, US Silica		75.76	37.9	3.45%
Calumite		0.0	0.0	0.00%
Salt Cake		21.0	10.5	0.96%
Melite - 40		0.62	0.3	0.03%
Soda Ash, FMC		222.3	111.2	10.14%
Coal, Carbocite #20		1.54	0.8	0.07%
Iron Chromite, $FeCr_2O_4$		7.378E+00	3.689E+00	3.364E-03
Chrome Oxide, Cr_2O_3		1.114E+00	5.568E-01	5.078E-04
TOTALS		2192.3	1096.1	99.95%
After Melting:				
Glass		2000.0	1000.0	
LOI		193.3	96.6	
Total		2193.3	1096.6	

Oxide Composition

Oxide	Wt. Pct.
SiO_2	71.4%
Al_2O_3	1.7%
CaO	11.3%
MgO	0.4%
Na_2O	14.1%
K_2O	0.2%
Fe_2O_3	0.250%
TiO_2	0.074%
S(total)	0.350%
Cr_2O_3	0.230%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Green
Thickness, mm		3.18
550 Transmission		70.2
Redox Number		-30.00

Figure 14(c)

Green Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Scenario Name: Beer Belt Blend

Cullet Percentage **75.0%**

Cullet Color Percents
55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1000 g glass)	Percent
Clear	825		412.5	
Amber	600		300.0	
Green	75		37.5	
TOTAL		1500	750	71.35%
Virgin Raw Materials				
Sand, US Silica		320.9	160.4	15.26%
Limestone		104.6	52.3	4.98%
Aplite, US Silica		39.31	19.7	1.87%
Calumite		0.0	0.0	0.00%
Salt Cake		16.2	8.1	0.77%
Melite - 40		0.51	0.3	0.02%
Soda Ash, FMC		111.5	55.7	5.30%
Coal, Carbocite #20		0.98	0.5	0.05%
Iron Chromite, $FeCr_2O_4$		4.776E+00	2.388E+00	2.272E-03
Chrome Oxide, Cr_2O_3		2.261E+00	1.130E+00	1.075E-03
TOTALS		2101.0	1050.5	99.94%
After Melting:				
Glass		2000.0	1000.0	
LOI		102.3	51.1	
Total		2102.3	1051.1	

Oxide Composition

Oxide	Wt. Pct.
SiO_2	71.2%
Al_2O_3	1.7%
CaO	11.3%
MgO	0.6%
Na_2O	14.1%
K_2O	0.2%
Fe_2O_3	0.250%
TiO_2	0.083%
S(total)	0.349%
Cr_2O_3	0.230%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Green
Thickness, mm		3.18
550 Transmission		70.2
Redox Number		-30.00

Figure 15(a)

Glass Batch Formulation with Mixed Cullet -- CLEAR(Flint) Glass

Page 1 -- Main Program: Raw Materials and Input Values

Raw Materials Data Base: Standard Soda Lime Silicate

Cullet Scenario Name: Beer Belt Blend

***** GLASS RAW MATERIALS *****

Cullet				SiO2	Al2O3	Co	CaO	MgO	Se	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	C	LOI	Total	COD
Clear				71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.15%	0.05%	0.20%	0.00%	0.05%	0.15%	99 99%	-1.19%
Amber				71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.29%	0.15%	0.25%	0.00%	0.10%	0.00%	100 18%	-2 37%
Green				71.90%	1.70%		11.10%	0.73%		13.80%	0.16%	0.20%	0.10%	0.20%	0.20%	0.05%	0.00%	100.14%	-1.19%
			Cost																
Raw Materials			$/ton																
Sand, US Silica			40.00	99.690%	0.094%		0.009%	0.006%		0.003%	0.016%	0.037%	0.023%			0.015%	0.122%	100.0%	0.00
Limestone			40.00	1.000%			54.910%	0.450%				0.050%				0.050%	43.590%	100.1%	-0.01
Aplite, US Silica			28.00	62.190%	22.320%		5.850%	0.036%		5.910%	2.750%	0.112%	0.530%	0.060%		0.012%	0.242%	100.0%	0 00
Calumite			32.00	36.480%	11.110%		36.930%	11.630%		0.500%	0.350%	0.280%	1.240%	1.250%		1.000%	0.230%	101.0%	-0.24
Salt Cake			100.00							43.600%				22.588%			33.812%	100.0%	1.00
Melite - 40			65 00	28.345%	8.632%		28 695%	9.037%		0.389%	0.272%	22.300%	0.963%			1.000%	1 368%	101 0%	-0.24
Soda Ash			84.00							58.400%							41 600%	100.0%	0.00
Carbocite #20			30.00	8 800%	6.099%		0.192%	0.096%		0.704%		0.330%	0.291%	0.038%		78.000%	5.450%	100.0%	-18.49
Ferro Cobalt Frit			1000.00	50.000%		5.000%				45.000%							0.000%	100.0%	0.00
Ferro Selenium Frit			1000 00	50.000%					2.000%	48.000%							0.000%	100.0%	0.00
Niter, NaNO3			200.00	0.00	0.00	0.00	0.00	0.00	0.00	36.470%	0.00	0.00	0.00	0.00	0.00	0.00	63 530%	100.0%	4.18

***** USER INPUT: SPECIFY CULLET USAGE HERE *****

Color Parameters	[Note: all color parameters are fixed. Algorithm calculates best flint composition for given cullet mix]	
Total Fe	8.4E-04	Minimum value determined from cullet and raw batch -- calculated by model
Total Cr	2.5E-05	Values determined from cullet and raw batch -- calculated by model
Total Fe & Cr	8.7E-04	Values determined from cullet and raw batch -- calculated by model
Required Se	3.0E-04	Each 0.02% Fe plus Cr in glass requires 60 ppm Se
Required Co	1.7E-05	Each 0.02% Fe plus Cr in glass requires 4 ppm Co
COD	10	Redox conditions set to oxidizing Note: LP algorithm is set to minimize Fe in glass
Neutral Tranmission [calc]	71.1	Neutral transmission based on green 450 extinction

Cullet, percent of glass:		25.0%
Three Mix Ratio:		
Clear	====>	55.0
Amber	====>	40.0
Green	====>	5.0

continued

Figure 15(b)

Glass Batch Formulation with Mixed Cullet – CLEAR(FLINT) GLASS

Page 2 – Main Program: Calculated Values

***** GLASS BATCH FORMULA (computed batch weights appear in Batch Column) *****

Cullet		Wt. Lbs	Percent	SiO2	Al2O3	Co	CaO	MgO	Se	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	C	LOI	Total	COD
TOTAL		500																	
Clear		275	13.75%	197.73	4.68	0.00	30.53	2.01	0.00	37.95	0.44	0.41	0.14	0.55	0.00	0.14	0.41	274.97	-3.26
Amber		200	10.00%	143.80	3.40	0.00	22.20	1.46	0.00	27.60	0.32	0.59	0.30	0.50	0.00	0.20	0.00	200.36	-4.74
Green		25	1.25%	17.98	0.43	0.00	2.78	0.18	0.00	3.45	0.04	0.05	0.03	0.05	0.05	0.01	0.00	25.04	-0.30
		Batch																	
Raw Materials		Weight	Cost	SiO2	Al2O3	Co	CaO	MgO	Se	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	C	LOI	Total	COD
Sand, US Silica		1010.0	20.20	1006.85	0.95	0.00	0.09	0.06	0.00	0.03	0.16	0.37	0.23	0.00	0.00	0.15	1.23	1010.13	-3.59
Limestone		287.5	5.75	2.87	0.00	0.00	157.84	1.29	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.14	125.30	287.60	-3.41
Aplite, US Silica		108.47	1.52	67.46	24.21	0.00	6.35	0.04	0.00	6.41	2.98	0.12	0.57	0.07	0.00	0.01	0.26	108.48	-0.31
Calumite		0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salt Cake		12.6	0.63	0.00	0.00	0.00	0.00	0.00	0.00	5.47	0.00	0.00	0.00	2.83	0.00	0.00	4.24	12.55	12.55
Melite - 40		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soda Ash, FMC		309.0	12.98	0.00	0.00	0.00	0.00	0.00	0.00	180.44	0.00	0.00	0.00	0.00	0.00	0.00	128.53	308.97	0.00
Carbocite #20		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferro Cobalt Frit		9.738E-01	0.49	0.49	0.00	0.05	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00
Ferro Selenium Frit		3.042E+01	15.21	15.21	0.00	0.00	0.00	0.00	0.61	14.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.42	0.00
Niter, NaNO3		3.125E+00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	1.99	3.12	13.05
TOTALS		2261.95	57.08	1452.38	33.66	0.05	219.78	5.04	0.61	277.53	3.94	1.69	1.26	4.00	0.05	0.66	261.97	2262.63	10.00

***** GLASS OXIDE FORMULA (Enter target glass composition) *****

		Total		Percent	Glass=100
Glass		2000.00		88.4%	100.00
LOI		262.63		11.6%	13.13
Total		2262.63		100.0%	113.13

Glass Oxides===>	SiO2	Al2O3	Co	CaO	MgO	Se	Na2O	K2O	Fe2O3	TiO2	S(total)	Cr2O3	C	COD
Target Glass (default given) ==>	71.90%	1.70%	1.74E-05	11.10%		3.04E-04	13.80%	0.16%			0.20%			10
Calculated Oxide Composition ==>	72.62%	1.68%	2.43E-05	10.99%	0.25%	3.04E-04	13.88%	0.20%	0.08%	0.06%	0.20%	0.002%	0.03%	10.00

***** *End of Main* *****

Figure 15(c)

Clear(Flint) Glass Batch Formulations Using 3-Mix Cullet Example Batches and Resultant Glass Properties

Melt Identification

Cullet Scenario Name: Beer Belt Blend

Cullet Percentage 25.0%

Cullet Color Percents
55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1 kg glass)	Percent
Clear	275		137.5	
Amber	200		100	
Green	25		12.5	
TOTAL		500	250	22.10%
Virgin Raw Materials				
Sand, US Silica		1010.0	505.0	44.64%
Limestone		287.5	143.7	12.70%
Aplite, US Silica		108.47	54.2	4.79%
Calumite		0.0	0.0	0.00%
Salt Cake		12.6	6.3	0.55%
Melite - 40		0.00	0.0	0.00%
Soda Ash		309.0	154.5	13.66%
Carbocite #20		0.000E+00	0.000E+00	0.00%
Ferro Cobalt Frit		9.738E-01	4.869E-01	4.304E-04
Ferro Selenium Frit		3.042E+01	1.521E+01	1.344E-02
Niter		3.125E+00	1.562E+00	1.383E-03
TOTALS		2258.8	1131.0	99.97%
After Melting:				
Glass		2000.0	1000.0	
LOI		262.6	131.3	
Total		2262.6	1131.3	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.6%
Al2O3	1.7%
CaO	11.0%
MgO	0.3%
Na2O	13.9%
K2O	0.2%
Fe2O3	0.084%
TiO2	0.063%
S(total)	0.200%
Cr2O3	0.002%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Clear
Thickness, mm		3.2
Neutral Grey Transmission		71.1
Chemical Oxygen Demand		10.00

End of Summary

Figure 15(d)
Clear(Flint) Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Cullet Scenario Name: Beer Belt Blend

Cullet Percentage **50.0%**

Cullet Color Percents
55.0 Clear
40.0 Amber
5.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1 kg glass)	Percent
Clear	550		275	
Amber	400		200	
Green	50		25	
TOTAL		1000	500	46.10%
Virgin Raw Materials				
Sand, US Silica		659.7	329.9	30.41%
Limestone		190.3	95.2	8.77%
Aplite, US Silica		71.86	35.9	3.31%
Calumite		0.0	0.0	0.00%
Salt Cake		7.8	3.9	0.36%
Melite - 40		0.00	0.0	0.00%
Soda Ash		185.7	92.9	8.56%
Carbocite #20		0.000E+00	0.000E+00	0.00%
Ferro Cobalt Frit		1.232E+00	6.158E-01	5.678E-04
Ferro Selenium Frit		4.589E+01	2.295E+01	2.116E-02
Niter		5.655E+00	2.828E+00	2.615E-03
TOTALS		2162.6	1084.1	99.96%
After Melting:				
Glass		2000.0	1000.0	
LOI		169.2	84.6	
Total		2169.2	1084.6	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.3%
Al2O3	1.7%
CaO	11.0%
MgO	0.4%
Na2O	13.9%
K2O	0.2%
Fe2O3	0.126%
TiO2	0.072%
S(total)	0.200%
Cr2O3	0.005%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Clear
Thickness, mm		3.2
Neutral Grey Transmission		62.4
Chemical Oxygen Demand		10.00

End of Summary

Figure 16(a)

Clear(Flint) Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Cullet Scenario Name: USA Production

Cullet Percentage **25.0%**

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

	Cullet	Total Batch		
	weight, lbs.	Weight, lbs.	Weight, g	
Cullet	(by color)	(2000 lbs glass)	(1 kg glass)	Percent
Clear	290		145	
Amber	160		80	
Green	50		25	
TOTAL		500	250	22.07%
Virgin Raw Materials				
Sand, US Silica		1010.8	505.4	44.62%
Limestone		295.8	147.9	13.06%
Aplite, US Silica		108.53	54.3	4.79%
Calumite		0.0	0.0	0.00%
Salt Cake		12.7	6.3	0.56%
Melite - 40		0.00	0.0	0.00%
Soda Ash		301.5	150.8	13.31%
Carbocite #20		1.761E-01	8.805E-02	0.01%
Ferro Cobalt Frit		6.991E-01	3.496E-01	3.086E-04
Ferro Selenium Frit		3.059E+01	1.529E+01	1.350E-02
Niter		3.791E+00	1.896E+00	1.677E-03
TOTALS		2260.9	1132.3	99.97%
After Melting:				
Glass		2001.5	1000.8	
LOI		263.8	131.9	
Total		2265.3	1132.7	

Oxide Composition

Oxide	Wt. Pct.
SiO2	72.6%
Al2O3	1.7%
CaO	11.2%
MgO	0.3%
Na2O	13.7%
K2O	0.2%
Fe2O3	0.082%
TiO2	0.062%
S(total)	0.200%
Cr2O3	0.005%
Total	100.0%

Glass Color and Redox Properties

Color (amber, green, clear)		Clear
Thickness, mm		3.2
Neutral Grey Transmission		71.0
Chemical Oxygen Demand		10.00

End of Summary

Figure 16(b)

Clear(Flint) Glass Batch Formulations Using 3-Mix Cullet
Example Batches and Resultant Glass Properties

Melt Identification

Cullet Scenario Name: USA Production

Cullet Percentage **50.0%**

Cullet Color Percents
58.0 Clear
32.0 Amber
10.0 Green

Batch Formulation

Oxide Composition

	Cullet	Total Batch				
	weight, lbs.	Weight, lbs.	Weight, g		Oxide	Wt. Pct.
Cullet	(by color)	(2000 lbs glass)	(1 kg glass)	Percent		
Clear	580		290		SiO2	72.3%
Amber	320		160		Al2O3	1.7%
Green	100		50		CaO	11.0%
TOTAL		1000	500	46.10%	MgO	0.4%
					Na2O	13.9%
Virgin Raw Materials					K2O	0.2%
Sand, US Silica		659.7	329.8	30.41%	Fe2O3	0.122%
Limestone		190.3	95.2	8.78%	TiO2	0.070%
Aplite, US Silica		71.86	35.9	3.31%	S(total)	0.200%
Calumite		0.0	0.0	0.00%	Cr2O3	0.010%
Salt Cake		8.0	4.0	0.37%		
Melite - 40		0.00	0.0	0.00%	Total	100.0%
Soda Ash		185.6	92.8	8.56%		
Carbocite #20		0.000E+00	0.000E+00	0.00%		
Ferro Cobalt Frit		1.300E+00	6.500E-01	5.994E-04		
Ferro Selenium Frit		4.605E+01	2.302E+01	2.123E-02		
Niter		5.386E+00	2.693E+00	2.490E-03		
TOTALS		2162.7	1084.1	99.96%		
After Melting:						
Glass		2000.0	1000.0			
LOI		169.0	84.5			
Total		2169.0	1084.5			

Glass Color and Redox Properties

Color (amber, green, clear)	Clear
Thickness, mm	3.2
Neutral Grey Transmission	62.3
Chemical Oxygen Demand	10.00

End of Summary